102 CALeb

JOHN FLUKE MFG. CO., INC. ■ MODEL 102

FLUKE

VAW METER

MEASURES
VOLTS — AMPERES — WATTS

FEATURES

- 20 cps to 100 kcps
- 10% and Unity Power Factor Ranges
- 1.5 to 600 Volts AC
- 0.0015 to 30 Amperes
- Negligible Circuit Burden
- True Electrodynamometer Action

DESCRIPTION

The Model 102 VAW Meter is an ideal instrument for measuring voltage (V), current (A), and power (W) over a wide frequency range. The Model 102 allows direct reading of voltage, current and power on a linear meter scale. Because of its high sensitivity, it is capable of reading power from microwatts to kilowatts. Because of its high input impedance and low shunt drop it produces negligible insertion effects on the circuit under test. Power readings are inherently without waveform error for all frequency components within the specified frequency range.

APPLICATION

The VAW Meter is ideally suited to measure the true power consumed by a wide variety of loads. This includes both linear and non-linear elements such as servo components, transformers, rectifiers--substantially any power consuming circuit configuration.

In addition, the instrument will be found exceptionally useful in measuring amplifier output power into the actual amplifier load; will, in fact, obsolete the substitution method of utilizing resistance loading for estimating amplifier power output.

102 SPECIFICATIONS

VOLTAGE (FULL-SCALE	CURRENT (FULL-SCALE	POWER	POWER FACTOR RANGE	FREQUENCY RESPONSE	ACCURACY (After corrections for shunt dissipation)	INPUT IMPEDANCE
1.5 - 600V	1.5 ma-30A	225 uw to 18 KW	1.0	20 cps - 40 kcps 40 kcps - 100 kcps	3% 10%	1 megohm 25 uufd
			0.1	20 cps - 20 kcps 20 kcps - 40 kcps	3% 10%	

GENERAL SPECIFICATIONS

VOLTAGE RANGES: 1.5, 3, 6, 15, 30, 60, 150, 300, 600 volts RMS full-scale, selected by voltage range switch on front panel.

CURRENT RANGES: 0.0015, 0.003, 0.006, 0.015, 0.03, 0.06, 0.15, 0.3, 0.6, 1.5, 3, 6, 15, 30 RMS amperes full-scale, selected by plugging in shunts on the front panel. Shunts are available separately in the above ranges.

POWER RANGES: Wattmeter readings are direct readings taking into account the "Power Factor" switch setting of either 0.1 or 1. With the "Power Factor" switch set at 1 the wattmeter reads VA cos ϕ; with the switch set at 0.1 the wattmeter reads 0.1 VA cos ϕ. Consequently, the full-scale watts range is from 225 microwatts to 18 kilowatts, or the product of any full-scale current, any full-scale voltage and either 0.1 or 1.

SHUNT DROP: 45 millivolts at full-scale current.

METER SCALES: Voltage, current and power are read on the same meter scales, with the selection of the desired quantity being determined by positioning the "VAW" switch.

INPUT VOLTAGE: 117/220/234 volts, 50 - 60 cps.

FINISH: Smooth gray baked enamel on front panel.

DIMENSIONS:
Cabinet Model -
13" wide x 10" high x 12" deep, exclusive of handles and knobs.
Rack Model -
19" wide x 10-1/2" high x 12" deep.

WEIGHT:
Cabinet Model -
Net weight, 27 pounds.
Shipping weight, 40 pounds.

Rack Model -
Net weight, 25 pounds.
Shipping weight, 38 pounds.

PRICE:
Cabinet Model - $660.00.
Rack Model (102R) - $680.00.
Current Shunts - $30.00 each.

All prices f.o.b. factory, Mountlake Terrace, Wash.

The right is reserved without notice, to make such changes in equipment, design, or components as engineering or manufacturing progress may warrant.

Prices subject to change without notice

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FLUKE

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MODEL 102 VAW METER

CALIBRATION PROCEDURE

Prepared by: George Gunby & Owen Green
Engineering Dept.

Revised
October, 1959

EQUIPMENT: H-P 200CD Oscillator
H-P 400L Voltmeter
Power Amplifier
.006A Calibration Shunt
Precision Resistors and Mica Capacitors called for in following instructions

ABBREVIATIONS: VAW = Volts, Amps., Watts Selector Switch
PF = Power Factor Switch
V = Volts Range Switch

CHECKOUT PROCEDURE

1. Visual Inspection -
   A. All tubes in proper sockets.
   B. Check solder connections - tube sockets and terminal boards.
   C. Check mechanical zero of meter.

2. Put 0 - 750 ma d-c ammeter in series with red tracer (-) and pin 2 (+) of V14 (5Y3).
   Connect nothing to H, G, or L posts - no shunt.
   Set V to 6 v.
   Set PF to 1.
   Set VAW to V or A.
   Turn power on - ammeter should read 110 ma ±15 ma. If okay, remove meter and solder lead in place.

3. Check B+ (pins 3 & 6 of V13). Set to 250 v via P8.
   Check ripple and regulation for 100-130 v line.
   Ripple - 6 mv maximum.
   Regulation - 1.5 v maximum.

4. Check filament voltages. Set 117 v line.
   V5 (pins 2 & 7) = 6.3 v ±.2 v.
   V8 (pins 2 & 7) = 6.3 v ±.2 v.
   Vary line voltage - V8 should stay within 6.0 - 7.1 v.

5. Check electrode potentials
   Pentodes (V2, V4, V5, V7) should read 100-150 v plate and 85-115 v screen.
   V6 should read 150-200 v plate,
   60-90 v screen
   Indicated bias points should read -1.6 v ±0.2 v.

For V1 (6SN7) pin 5 = 160 ± 30 v
pin 2 = 130 ± 30 v
pin 6 = 5.7 ± 1 v

For V9 (6SN7) pin 5 = 210 ± 20 v
pin 2 = 110 ± 20 v
pin 6 = 9 ± 1 v

For V3 & V8 pin 8 = 22 ± 2 v

6. Plug in .006 amp. shunt.
Turn VAW switch to V - meter should read 0.
Turn VAW switch to A - meter should read 0.

If any deflection, check for oscillation at pin 4 of V9 with oscilloscope (input grid of VTVM tube).

7. Full scale V and A.
Set V to 6 v.
Put 1 k across H and G.
Set VAW to V.
Connect H-P400L from L to G.
Set osc. ampl. so that 400L reads 45 mv.

Adjust P2 so that meter indicates fs volts.

Set VAW to A.

Adjust P1 so that meter indicates fs amps.

8. W zero knob range.

Set VAW switch to W. Select V3 and V8 (6V6) to effect meter zero with W zero knob somewhere in its range. Then trim R12 or R32 (150 k) to center W zero knob. Use nothing smaller than 220 k.

9. W scale zero for fs V, zero A.

Set PF to .1.
Set VAW to W and set zero watts.
Set VAW to V.
Connect osc. to H and G and nothing to H and L.
Set osc. to give 80 to 100% fs V.
Switch VAW to W; it should read zero.

If not, adjust P3. If adjustment cannot be made with P3, shunt R54 or R55 to bring P3 in range. Value may be from 0 to 10 k.

10. W Scale zero for fs A, zero V.

Set osc. amplitude to zero.
Short H to G.
Connect osc. in series with 1 k resistor to H and L.
Set VAW to A.
Adjust osc. to give 80-100% fs A.
Switch VAW to W, it should read zero.

If not, trim either R117 or R118. Value may be from 1 mΩ to 10 mΩ.

11. Repeat 9 and 10 above to be sure adjustments have been correctly made.

12. Full scale W, PF = 1.

Set PF to 1.
Connect osc. to H and G.
Put 1 k across H and L.
Connect H-P400L from L to G.
Set osc. amp. so that 400L reads 45 mv.
Set VAW to W.
Adjust P4 for fs watts. It may be necessary to trim R52 to effect adjustment.
(Shunt R52 with 100Ω)

13. 6V6 linearity.

Set PF to .1.
Zero W scale.
Set VAW to A.
Set osc. to 2 kc.
Connect osc. to H and G posts.
Connect series load of .1 mfd and 67.5Ω to H and L posts.
Increase gain of osc. to give full scale A reading.
Set VAW to W and note reading.
Turn osc. to zero, change .1 mfd to .4 mfd, switch VAW to A.
Increase gain of osc. to give full scale A reading.
Set VAW to W. Reading should be the same as with the .1 mfd capacitor.

NOTE 1: If the two W readings in 13 above are not identical, replace one or both of the 6V6's, and repeat steps 8 thru 13.

NOTE 2: If it appears that no combination of 6V6's will cause the W readings to coincide, an abnormal circuit condition is indicated. This may be due to unusual non-linearities in the other amplifier tubes, faulty components, or, rarely, an unstable multiplier unit (S-can). There is no reason to suspect improper functioning of the multiplier unit, however, unless all other possible causes of trouble have been eliminated.

14. Full scale W, PF = .1

Set PF to .1.
Connect load of .1 mfd in series with 67.5Ω from H to L.
Zero W scale.
Set VAW to W - it should read 75% fs (27 for fs of 36).

Adjust P6 for 75% fs. If necessary, shunt R53 with 100Ω to effect adjustment.

As a check, change load to .4 mfd in series with 17.5Ω.
Set VAW to A.
Adjust osc. for fs A.
Set VAW to W - should read 25% fs (9 for fs of 36).
Set V to 3V - W should read 50% fs.
Set V to 1.5V - W should read 100% fs.

15. Checkout procedure is complete. Remove shunt and other calibrating equipment, plug 102 in to cook for 40 hours before final calibration.

FINAL CALIBRATION PROCEDURE

(Allow 15 minute warmup.)

1. Repeat steps 7 thru 13 of checkout procedure.

2. W zero for fs V, no A and fs A, no V, 20 kc.

Repeat steps 9 and 10 in Checkout Procedure, but with osc. set for 20 kc.
Do not disturb adjustments made in steps 9 and 10.

If there is more than 1% of fs shift in W zero, some tube in the amplifier chain needs replacing.

3. W reading at 20 kc.

Set osc. to 20 kc and connect to H and G.
Connect load of .01 mfd in series with 67.5Ω across H and L.
Set PF to .1.
Switch VAW to A.
Connect H-P400L across .006A shunt.
Set osc. output to give .006A. (fs)
Set VAW to W - should read 75% fs.

If not, trim R22 with 7-35 mmfd. (C50)

4. Reduce osc. output to zero.

Set V to 1.5V.
Change load to .04 mfd in series with 17.5Ω.
Set VAW to A, adjust osc. for fs A.
Switch VAW to W, should read 100% fs.

If not, trim R103 with 15-100 mmfd.

Switch V to 3V, W should read 50% fs.

5. 20 cps W zero check.

Set osc. amplitude to zero, freq. to 20 cps, and connect to H and G.
Connect load of 5 mfd.
Set V to 6V.
Set PF to .1.
Switch VAW to A.
Increase osc. amplitude to give .006 A.
Switch VAW to W - should read 7.5% fs.

If not, increase or decrease R14 - value should be 1 m - 10 m. If correct results not obtained, check coupling capacitors in amp., particularly C17 which may be increased if necessary.

Check voltage ranges of 15-600V.
Use power amplifier.

6. Set PF to 1.
Set VAW to V.
Set osc. to 2 kc. Connect power amplifier output to H and G.

A. Switch V to 600V.
Change load to 50 k.
Increase osc. amplitude so that H-P400L reads 45 mv.

Check that V reads 300V on 600V scale.

B. Switch V to 300V.
Check that V reads 300V on 300V scale.

C. Decrease osc. amplitude so that H-P400L reads 22.5 mv.
Switch V to 150V.
Check that V reads 150V on 150V scale.

D. Set V to 15V.
Use load of 5 k.
Connect H-P400L Across shunt.
Set osc. amplitude so that H-P400L reads 22.5 mv.

Check that V reads full scale.

E. Switch V to 30V.
Increase osc. amplitude so that H-P400L reads 45 mv.

Check that V reads full scale.

F. Switch V to 60V.
Increase osc. amplitude so that H-P400L reads 45 mv.

Check that V reads 30V on the 60V scale.

.1 PF VOLTAGE ADJUSTMENTS

7. A. Set V to 60V.
B. Set VAW to A.
C. Set PF to .1.
D. Set osc. amplitude to 0, f to 20 kc, power amplifier output to H and G.
E. Load H and L with .0015 mfd.
F. Set osc. for FSA.
G. Set VAW to W.

W should read .75% fs (1/4 division) - Adjust C41

8. Set V to 30V.
Repeat B, C, D above.
Load H and L with .0025 mfd.
Set osc. for fs A.
Set VAW to W.

W should read 1.5% of fs (1/2 division) - Adjust C47 - May require padding with 39 mmf.

9. Set V to 15V.
Load H and L with .004 mfd (.0015 + .0025)
Set osc. for fs A. W should read 3% of fs - Adjust C46.

10. Set V to 600V.
Load H and L with .00015 mfd.
Set osc. for fs A.

W should read 0 - Adjust C40 (C45 may need to be reduced)

11. Set V to 300V.
Load H and L with .00025 mfd.
Set osc. for fs A.

W should read 0. Adjust C49.

12. Set V to 150V.
Load H and L with .0004 mfd (.00015 + .00025)
Set osc. for fs A.

W should read 0 - Adjust C48 (may require 82 mmf from G to C48)

CALIBRATION COMPLETE

102 TEST RECORD

Serial No.:_____ Technician:_____ Date:_____

TURN ON

1. Visual inspection _____
2. Mech. Meter zero _____
3. Adj. P8 250V B+ _____p/m 0.5V
4. 250V Reg. _____l/t 1.5V, 105-130V line
5. 250V Ripple _____l/t 6 mv
6. Pwr. consumption _____approx. 130W
7. Bias 1.6V _____p/m 0.2V

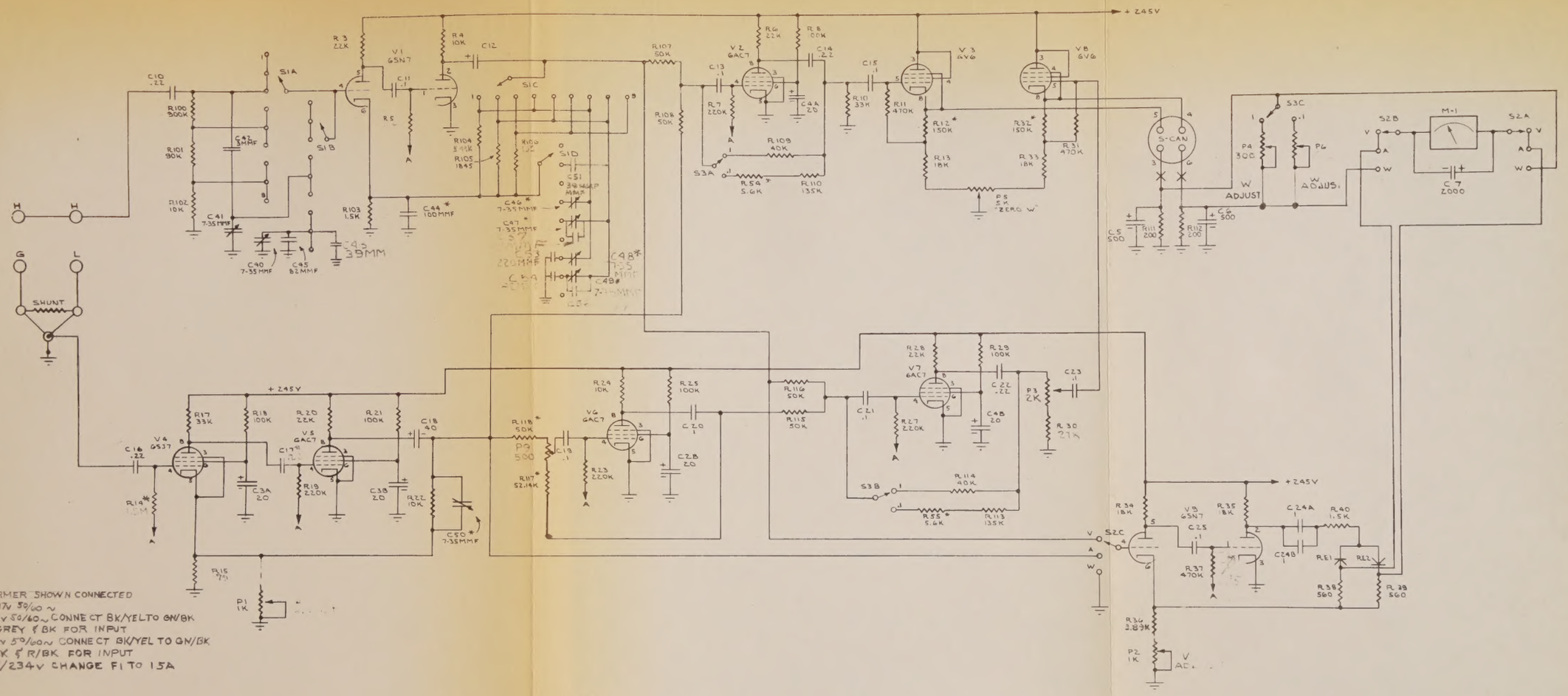
PRE-CALIBRATION TESTS

8. Set all potentiometers (except P8) and all trimmer capacitors to mid-range.
9. Connect .006 A shunt & 1k resistive load. Select V3 & V8 for balance so that WATTS ZERO ADJUST is within 90° of mid-range.
10. With proper signal applied: (On 6V range)
    a. Check that P2 can be set for FS volts._____
    b. Check that P1 can be set for FS amperes_____
    c. Check that P4 can be set for FS watts (p.f. 1.0)_____
    d. Check for NWT.
    e. Allow instrument to age at normal (or cycled) line voltage for 48 hours_____

FINAL CALIBRATION

11. Set all ranges within p/m 1.5% of FS. _____
12. Recheck 250V. _____
13. Recheck meter mech. zero and ZERO WATTS. _____
14. .006 A shunt, 45 mv at 2 kc developed across shunt:
    a. Adj. P2 for FS volts. Check at 20 kc & 40 kc _____p/m 5%
    b. Adj. P1 for FS amps. Check at 20 kc & 40 kc _____p/m 5%
    c. Adj. P3 for zero watts w/FS volts applied & zero current. Recheck at 20 kc (p.f.-0.1) & 40 kc _____p/m 5%
    d. Adj. P9 for zero watts w/FS amps & zero volts applied. Recheck at 20 kc (0.1 p.f.) & 40 kc _____p/m 5%
    e. Adj. P4 for FS watts w/FS volts & amps applied. (1.0 pf, 2 kc). Recheck WATTS ZERO before and after this adjustment. _____
15. w. Linearity (Step #13 Test Procedure) _____l/t 0.5%
16. Adj. P6 for 75% FS watts (2 kc, MM 0.1 p.f.) _____
17. 25% FS w/change in load (6V range) _____p/m 1%
18. 50% FS on 3V range _____p/m 1%
19. 100% FS on 1.5V range _____p/m 1%
20. Adj. C50 for 75% FS watts at 20 kc & 40 kc (0.1 p.f.) _____p/m 5%
21. 100% FS 1.5V range w/change in load _____
22. 7.5% FS watts at 30 cps (0.1 p.f.) (Adj. R14 1 to 10M)_____
23. Check linearity all voltage ranges _____
24. 0.1 p.f. adjustments at 20 kc
    a. Adj. C41 for 0.75% FS watts (60V range) _____
    b. Adj. C47 for 1.5% FS watts (30V range) _____
    c. Adj. C46 for 3.0% FS watts (15V range) _____
    d. Adj. C40 for Zero watts (600V range) _____
    e. Adj. C49 for Zero watts (300V range) _____
    f. Adj. C48 for Zero watts (150V range) _____

Note: 0.1 p.f. adjustments may require component selection. If so, consult Cal. Manual.


+245V
SHUNT
H
L
G
V1 6SN7
V2 6AC7
V3 6V6
V4 6S37
V5 6AC7
V6 6AC7
V7 6AC7
V8 6V6
V9 6SN7
S-CAN
S1A
S1B
S1C
S1D
S2A
S2B
S2C
S3A
S3B
S3C
M-1
W ADJUST
ZERO W
ADJUST
+245V
P1 1K
P2 1K
V AC
P3 2K
P4 300
P5 5K
P6
P7 500
P8 5K
R1 3.89K
R2 1.5K
R3 22K
R4 10K
R5
R6 22K
R7 220K
R8 100K
R9 40K
R10 33K
R11 470K
R12 150K
R13 18K
R14 1.5M
R15 1M
R16 50K
R17 33K
R18 100K
R19 220K
R20 22K
R21 100K
R22 10K
R23 220K
R24 10K
R25 100K
R26 22K
R27 220K
R28 22K
R29 100K
R30 2M
R31 470K
R32 150K
R33 18K
R34 18K
R35 18K
R36 3.89K
R37 470K
R38 560
R39 1.5K
R40 1.5K
R41 15
R42 82K
R43 23K
R44 470K
R45 12K
R46 330K
R47 270K
R48 470K
R49 470K
R50
R51 4.7K
R54 5.6K
R55 5.6K
R100 300K
R101 90K
R102 10K
R103 1.5K
R104 5.1K
R105 1845
R106 22
R107 50K
R108 50K
R109 40K
R110 135K
R111 200
R112 200
R113 135K
R114 40K
R115 50K
R116 50K
R117 52.14K
R118 50K
C1A 20
C1B 20
C2A 20
C2B 20
C3A 20
C3B 20
C4A 20
C4B 20
C5 500
C6 500
C7 2000
C8 200/6
C10 .22
C11 .1
C12
C13 .1
C14 .22
C15 .1
C16 .22
C17
C18 40
C20 .1
C21 .1
C22 .22
C23 .1
C24A 1
C24B 1
C25 .1
C26 .22
C27 .22
C28 16
C40 7-35MMF
C41 7-35MMF
C42 3MMF
C43 39MM
C44 100MMF
C45 82MMF
C46 7-35MMF
C47 7-35MMF
C48 7-35MMF
C49 7-35MMF
C50 7-35MMF
C51 39 MMF
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